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Birds surveyed in the harvested and unharvested areas of a reduced-impact logged forestry concession, located in the lowland subtropical humid forests of the Department of Santa Cruz, Bolivia.

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Abstract
As part of a larger study of reduced-impact logging effects on bird community composition, we surveyed birds from December to February during the 2003-2004 wet-season within harvested and unharvested blocks of the La Chonta forestry concession, Department of Santa Cruz, Bolivia. The logged forest was harvested using reduced-impact logging techniques between one and four years previously. During point count surveys, we identified 5062 individual birds, belonging to 155 species, and 33 families. We provide a list of bird species found within the harvested and unharvested blocks of the concession for the benefit of other researchers assessing the responses of Neotropical avifauna to disturbance, and to facilitate increased understanding of the diverse bird assemblages found within the lowland subtropical humid forests of Bolivia.

Introduction

There are over 1400 species of birds known from Bolivia, with the majority of species found in the sub-tropical and tropical forests of lowland Bolivia (Pacheco 1998). Almost half of forests in lowland Bolivia are now granted to forestry concessions (Mostacedo and Fredericksen 1999). In 1996, a new forestry law was enacted to promote the sustainable harvesting of timber (Mostacedo and Fredericksen 1999). To achieve best-management practices, reduced-impact logging techniques have gained widespread application in Bolivia and, as of 2005, concessions covering over 2.2 million hectares had obtained certification by the Forest Stewardship Council (Forest Stewardship Council 2005). Here, we provide the results of a wet season bird survey of the harvested and unharvested areas on one of these certified concessions located in the lowland subtropical humid forests of the Department of Santa Cruz, Bolivia.

Material and Methods

Study site

Our study area was located in the lowland subtropical humid forest of the Guarayos Forest Reserve, Department of Santa Cruz, Bolivia. Research was conducted in the 100000 ha forestry concession "La Chonta". This is owned and managed by Agroindustria Forestal La Chonta (509000 to 545000 easting, 8275500 to 824900 northing; Figure 1). The forest has an average elevation of 320 m (range 230-390m). The soils consist of oxisols, ultisols, and inceptisols (Park et al. 2005). The mean annual temperature is 25° C with a mean annual precipitation of approximately 1560 mm. The region experiences a distinct dry season from May to October. The entire concession was subjected to legal and illegal selective logging of mahogany (*Swietenia macrophylla*), and Spanish cedar (*Cedrela odorata*) from ~1980 to 1995. The concession was certified by SmartWood in 1998.

Harvesting procedure

Approximately 2500 ha of forest is harvested annually over three contiguous 850 ha blocks (~4 x 2 km), yielding 50000 m^3 of timber. Eighteen tree species were harvested during the time of this study (2003-2004) including *Ficus boliviana*, *Hura crepitans*, *Terminalia oblonga*, *Cariana ianeirensis*, *C. estrellensis*, and *Pseudolmedia laevis*. Average harvest intensity was approximately 4 trees per ha (Jackson et al. 2002). The forestry company Agroindustria Forestal La Chonta conducts inventories of harvestable trees one year prior to logging. The minimum size for harvest is 50 cm diameter at breast-height (dbh) for all species except *F. boliviensis* and *H. crepitans*, which are harvested above 70 cm dbh. One in five harvestable trees is required by law to be left as a

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seed tree. During pre-harvesting inventory, trees selected for felling are cleared of all vines from their bole. The forestry company uses a 'fishbone' harvesting strategy with a single primary north-south road bisecting each 850 ha block. Skid trails are located 100-150 m apart and run in an east-west direction on either side of the primary road. Chainsaw teams trained in directional felling techniques try to reduce damage to the residual stand during logging. Removal and loading of boles is conducted using rubber-tired skidders to reduce soil compaction. It is intended that blocks be re-cut in 25 to 30 years.

Survey design

A stratified-random sampling design was used. The strata to guide site selection included commercial tree species occurrence, vegetation height, and disturbance type. Five habitat types were surveyed including: 1. 'Tall forest' points (T) with vegetation height over 20 m and possessing one of five commercial tree species (*Ficus boliviensis*, *Hura crepitans*, *Cariniana estrellensis*, *C. ianeirensis*, *Terminalia oblonga*) of harvestable size; 2. 'Medium forest' points (F) from 12-20 m in height and possessing a commercial tree of the afore mentioned five species not yet of harvestable size but above 30 cm dbh; 3. 'Vine thicket' points (N) of less than 12m in height and not possessing commercial trees above 10 cm dbh; 4. 'Gap' points (G) possessing a tree-fall gap caused by the felling of a tree (in the harvested blocks) or a natural tree fall (in the unlogged blocks) of greater than 50 cm dbh; and 5. 'Road' points (R) located on a primary north-south logging road in the logged forest, or along the main north-south access path in the unlogged forest. In total, 360 points was surveyed, equally distributed between the logged and unlogged forest, represented by 72 points of each of the five habitat categories.

Bird surveys

At each of the 360 survey points, we used an unlimited distance point-count method of surveying bird species abundance. All survey points were located at least 300 m from the nearest point, and at least 500 m from the edge of neighbouring treatment blocks. Surveys were conducted from December to February of the 2003-2004 wet season. Surveys began at first light (5:45-6:00 am), and continued until approximately 10:45 am. Counts were not undertaken if weather was poor (e.g. rain, high wind). This period overlapped with the daily peak in bird vocal activity. A day's survey consisted of visiting three points of each of the five habitat types (15 points in total). Each point was surveyed for 12 minutes. We included birds flushed from the survey point on approach by the observer, while birds flying over the survey area were not included in the analysis.

Due to the density of forest vegetation, most identifications were made acoustically, rather than visually. In addition to point counts, recordings of birds were made using a Sony TCM 5000 tape-recorder that was attached to a Sennheiser ME66 microphone. These recordings were used as a supplement to in-the-field identification of vocalizing species. For unidentified species, symbolic representations of songs were noted. This was in addition to notes on the recording time, direction, and estimated distance to the call. This enabled the matching of subsequent identifications with abundance and distance information. Unknown recordings were identified using the CD-ROM Birds of Bolivia, 2.0 (Mayer, 2000), or by an expert (B.H). All research was approved by the relevant authorities and this study was conducted within the ethical guidelines of Australia and Bolivia.

Figure 1. Map of Bolivia with approximate location of the la Chonta forestry concession indicated within the department of Santa Cruz.

Results and discussion

This survey was part of a larger study assessing the effects of reduced-impact logging on bird community composition and abundance. The list should be of benefit to other researchers assessing disturbance associated responses of Neotropical avifauna, and to facilitate increased understanding of the diverse bird assemblages found within the lowland subtropical forests of Bolivia. During point count surveys, we identified approximately 5 050 birds, belonging to 155 species, and 33 families (see Table 1).

Outside of the survey period, several species were noted in addition to those accounted for within the forested areas of the concession. These included the harpy eagle (*Harpia harpyja*), crested eagle (*Morphnus guianensis*), great razor-billed curassow (*Mitu tuberosa*), bare-faced curassow (Crax fasciolata), ferruginous pygmy-owl (*Glaucidium brasilianum*), common potoo (*Nyctibius griseus*), pauraque (*Nyctidromus albicollis*) and bare-necked fruitcrow (*Querula purpurata*).

Although avian species richness was nearly identical between the harvested and unharvested areas of the concession (logged 132 spp.; unlogged 133 spp.), this numerical equivalence obscures underlying differences in species composition. Our results suggest that the avian families Ramphastidae, Falconidae and Formicariidae were adversely affected by the logging activities in this forest. At the species level, concern may be warranted regarding the absence of the Barred-forest falcon and the lower abundances of Red-necked Woodpecker, Channel-billed Toucan, Red-billed Toucan, Black-faced Antthrush, Spot-backed Antbird, and Gray-fronted dove within the harvested areas of the concession. In contrast, the Black-throated Antbird, Yellow-tufted Woodpecker, Buff-throated Saltator, and Moustached Wren, appear to be currently benefiting from logging associated disturbance.

Due to temporal and seasonal variation in bird species vocalization and presence, results should be interpreted acknowledging the season of the survey and the time of day during which the surveys were carried out. It should also be acknowledged that the mere presence of a species in an area does not necessarily mean that the area possessed suitable habitat for that species' long-term persistence (O'Brien et al., 2003). At the time of the survey, the first logging rotation for the concession was not as yet completed, and disturbance processes associated with selective logging activity occurred from only one to four years previously. This temporal period of disturbance is well short of that by which most localized avian extinctions are predicted to occur following anthropogenic disturbance processes (Robinson 1999; Mason and Thiollay 2001).

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Table 1. Bird species encountered during bird surveys conducted from December 2003 to February 2004 within 360 sampling points equally distributed between the harvested (Log) and unharvested (Unl) blocks of the reduced-impact logged La Chonta concession, Department of Santa Cruz, Bolivia. Bird abundance is grouped according to the number of total contacts made during the survey within the harvested and unharvested areas. Birds are labeled either as abundant (ab; >99), common (com; >29), uncommon (unc; 9>n<30), rare (rar; 2>n<10), present (pre; 1, 2), or not observed (- ; 0).

Scientific name	Common name	Unl	Log
Tinamidae			
Crypturellus soui	Little Tinamou	unc	unc
Crypturellus cinereous	Cinereous Tinamou	unc	unc
Crypturellus strigulosus	Brazilian Tinamou	rar	unc
Crypturellus tataupa	Tatapua Tinamou	rar	pre
Crypturellus undulatus	Undulated Tinamou	com	com
Tinamous tao	Gray Tinamou	pre	pre
Cathartidae			
Sarcoramphus papa	King Vulture	-	pre
Accipitridae			
Spizaetus ornatus	Ornate Hawk-eagle	pre	pre
Spizaetus tyrannus	Black Hawk-eagle	pre	-
Falconidae			
Micrastur ruficollis	Barred Forest-falcon	rar	-
Falco rufigularis	Bat Falcon	pre	-
Micrastur gilvicollis	Lined Forest-falcon	pre	-
Micrastur semitorquatus	Collared Forest-falcon	pre	-
Cracidae			
Penelope jaquacu	Spix's Guan	rar	rar
Pipile pipile	Blue-Throated Piping-guan	pre	pre
Columbidae			
Columba speciosa	Scaled Pigeon	unc	com
Columba plumbea	Plumbeous Pigeon	unc	unc
Columbia subvinacea	Ruddy Pigeon	com	com
Claravis pretiosa	Blue Ground-dove	com	com
Geotrygon montana	Ruddy Quail-dove	rar	pre
L*eptotila rufaxilla*	Gray-fronted dove	com	unc

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Scientific name (cont.)	Common name	Unl	Log
Psittacidae			
Brotogeris cyanoptera	Cobalt-winged Parakeet	unc	com
Pyrrhura molinae	Green-cheeked Parakeet	unc	unc
Pionus menstruus	Blue-headed Parrot	unc	unc
Ara severa	Chestnut-fronted Macaw	rar	unc
Ara chloroptera	Red and Green Macaw	rar	unc
Ara arauna	Blue and Yellow Macaw	rar	rar
Aratinga leucophthalmus	White-eyed Parakeet	-	pre
Amazona farinosa	Mealy Parrot	com	com
Cuculidae			
Piaya cayana	Squirrel Cuckoo	unc	unc
Tapera naevia	Striped Cuckoo	pre	-
Coccyzus americanus	Yellow-billed Cuckoo	-	pre
Strigidae			
Otus watsonii	Tawny-bellied Screech-owl	pre	rar
Ciccaba huhula	Black-banded owl	pre	-
Carpimulgidae			
Nyctiphrynus ocellatus	Ocellated Poorwill	rar	unc
Trochilidae			
Phaethornis ruber	Reddish Hermit	unc	unc
Thalurania furcata	Fork-tailed Woodnymph	rar	pre
Phaethornis hispidus	White-bearded Hermit	rar	-
Heliothryx barroti	Purple-crowned Fairy	pre	pre
Glaucis hirsuta	Rufous-breasted Hermit	pre	-
Hylocharis cyanus	White-chinned Sapphire	com	rar
Trogonidae			
Trogon curucui	Blue-crowned Trogon	unc	unc
Trogon collaris	Collared Trogon	com	com
Trogon melanurus	Black-tailed Trogon	com	com
Motmotidae			
Motmotus motmota	Blue-crowned Motmot	unc	com
Bucconidae			
Monasa morphoeus	White-fronted Nunbird	unc	unc
Monasa nigrifrons	Black-fronted Nunbird	com	com
Nonnula ruficapilla	Gray-cheeked Nunlet	rar	rar
Nystalus striolatus	Striolated Puffbird	rar	rar
Notharcus macrohynchos	White-necked Puffbird	-	rar
Galbulidae			
Galbula ruficauda	Rufous-tailed Jacamar	pre	pre
Brachygalba lugubris	Brown Jacamar	-	pre
Ramphastidae			
Pteroglossus castanotis	Chestnut-eared Aracari	rar	rar
Ramphastos tucanus	Red-billed Toucan	com	unc
Rhamphastos vitellinus	Channel-billed Toucan	com	unc
Picidae			
Melanerpes cruentatus	Yellow-tufted Woodpecker	unc	com
Campephilus rubricollis	Red-necked Woodpecker	unc	rar
Piculus leucolaemus	White-throated Woodpecker	rar	pre
Celeus torquatus	Ringed Woodpecker	pre	rar
Picumnus aurifrons	Bar-breasted Piculet	pre	-

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Scientific name (cont.)	Common name	Unl	Log
Dendrocolaptidae			
Dendrexetastes certhia	Cinnamon-throated Woodcreeper	unc	unc
Lepidocolaptes albolineatus	Lineated Woodcreeper	rar	rar
Sittasomus griseicapillus	Olivaceous Woodcreeper	rar	rar
Dendrocolaptes certhia	Barred Woodcreeper	rar	pre
Dendrocolaptes piccumnus	Black-banded Woodcreeper	pre	pre
Nasica longirostris	Long-billed Woodcreeper	pre	pre
Dendrocincla fuliginosa	Plain-brown Woodcreeper	pre	-
Xiphorhyncus guttatus	Buff-throated Woodcreeper	com	com
Formicariidae			
Hylopezus berlepschi	Amazonian Antpitta	-	pre
Formicarius analis	Black-faced Antthrush	com	unc
Myrmeciza atrothorax	Black-throated Antbird	unc	com
Thamnophilus amazonicus	Amazonian Antshrike	unc	unc
Hylophylax naevius	Spot-backed Antbird	unc	rar
Myrmotherula axillaris	White-flanked Antwren	rar	rar
Thamnophilus sticturus	Bolivian-slaty Antshrike	rar	rar
Hylophylax poecilonota	Scale-backed Antbird	rar	rar
Pyriglena leuconota	White-backed Fire-eye	pre	rar
Phlegopsis nigromaculata	Black-spotted Bare-eye	pre	pre
Hypocnemoides maculicauda	Band-tailed Antbird	pre	-
Myrmeciza hemimelaena	Chestnut-tailed Antbird	com	com
Thamnophilus palliatus	Chestnut-backed Antshrike	com	com
Dysithamnus mentalis	Plain Antvireo	com	com
Herpsilochmus rufimarginatus	Rufous-winged Antwren	ab	ab
Thamnophilus schistaceus	Plain-winged Antshrike	ab	ab
Cercomacra cinerascens	Gray Antbird	ab	ab
Hypocnemis cantator	Warbling Antbird	ab	com
Tyrannidae			
Myiarchus tuberculifer	Dusky-capped Flycatcher	unc	com
Tolmomyias assimilis	Yellow-margined Flycatcher	unc	unc
Hemitriccus flammulatus	Flammulated Bamboo-Tyrant	unc	unc
Attila spadiceus	Bright-rumped Attila	unc	unc
Rhytipterna simplex	Grayish Mourner	unc	unc
Myiornis ecaudatus	Short-tailed Pygmy-Tyrant	rar	unc
Legatus leucophaeus	Piratic Flycatcher	rar	rar
Tolmomyias sulphurescens	Yellow-olive Flycatcher	rar	rar
Hemitriccus minor	Snethlage's Tody-tyrant	rar	pre
Ramphotrigon ruficauda	Rufous-tailed Flatbill	rar	-
Onychorhynchus coronatus	Amazonian Royal Flycatcher	pre	rar
Lathrotriccus euleri	Euler's Flycatcher	pre	pre
Casiornis rufa	Rufous Casiornis	pre	-
Myiodynastes maculatus	Streaked Flycatcher	pre	-
Tityra cayana	Black-tailed Tityra	pre	-
Attila bolivianus	White-eyed Attila	-	pre
Leptopogon amaurocephalus	Sepia-capped Flycatcher	-	pre
Pachyramphus marginatus	Black-capped Becard	-	pre
Pachyramphus minor	Pink-throated Becard	-	pre
Pachyramphus polychopterus	White-winged Becard	-	pre
Tyrannus melancholicus	Tropical Kingbird	-	pre
Myiopagis gaimardi	Forest Elaenia	com	com
Corythopis torquata	Ringed Antpipit	com	unc

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Scientific name (cont.)	Common name	Unl	Log
Furnariidae			
Automolus ochrolaemus	Buff-throated Foliage-Gleaner	unc	unc
Xenops rutilans	Streaked Xenops	rar	pre
Cotingidae			
Laniocera hypopyrra	Cinereous Mourner	rar	rar
Cephalopterus ornatus	Amazonian Umbrellabird	-	pre
Lipaugus vociferans	Screaming Piha	ab	ab
Pipridae			
Machaeropterus pyrocephalus	Fiery-capped Manakin	unc	unc
Neopelma sulphureiventer	Sulphur-bellied Tyrant-Manakin	unc	unc
Piprites chloris	Wing-barred Piprites	rar	pre
Pipra fasciicauda	Band-tailed Manakin	pre	pre
Pipra rubrocapilla	Red-headed Manakin	pre	-
Troglodytidae			
Thryothorus genibarbis	Moustached Wren	unc	unc
Thryothorus guarayanus	Fawn-breasted Wren	rar	rar
Campylorhynchus turdinus	Thrush-like Wren	-	pre
Microcerculus marginatus	Scaly-breasted Wren	-	pre
Sylviinae			
Ramphocaenus melanurus	Long-billed gnatwren	com	unc
Turdinae			
Turdus albicollis	White-necked Thrush	unc	unc
Turdus amaurochalinus	Creamy-bellied Thrush	pre	pre
Turdus hauxwelli	Hauxwell's Thrush	-	pre
Vireonidae			
Cyclarhis gujanensis	Rufous-browed Peppershrike	rar	unc
Hylophilus pectoralis	Ashy-headed Greenlet	pre	pre
Hylophilus muscicapinus	Buff-cheeked Greenlet	com	com
Emberizinae			
Arremon taciturnus	Pectoral Sparrow	rar	rar
Cardinalinae			
Cyanocompsa cyanoides	Blue-black Grosbeak	unc	unc
Saltator maximus	Buff-throated Saltator	-	rar
Thraupinae			
Tangara chilensis	Paradise Tanager	unc	unc
Hemithraupis guira	Guira Tanager	rar	pre
Euphonia rufiventris	Rufous-bellied Euphonia	pre	rar
Euphonia cyanocephala	Golden-rumped Euphonia	pre	pre
Euphonia chrysopasta	White-lored Euphonia	pre	-
Tachyphonus luctuosus	White-shouldered Tanager	pre	-
Euphonia laniirostris	Thick-billed Euphonia	pre	-
Euphonia xanthogaster	Orange-bellied Euphonia	pre	-
Tachyphonus cristatus	Flame-crested Tanager	pre	-
Ramphocelus carbo	Silver-beaked Tanager	-	rar
Dacnis cayana	Blue Dacnis	-	pre
Eucometis penicillata	Gray-headed Tanager	-	pre
Thraupis sayaca	Sayaca Tanager	-	pre
Thraupis palmarum	Palm Tanager	-	pre
Habia rubica	Red-crowned Ant-tanager	com	com
Coereba flaveola	Bananaquit	rar	rar

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Scientific name (cont.)	Common name	Unl	Log
Parulidae			
Basileuterus culicivorus	Golden-crowned Warbler	unc	com
Parula pitiayumi	Tropical Parula	rar	rar
Icteridae			
Psarocolius decumanus	Crested Oropendola	rar	pre
Psarocolius bifasciatus	Olive Oropendola	rar	-
Cacicus cela	Yellow-rumped Cacique	-	pre